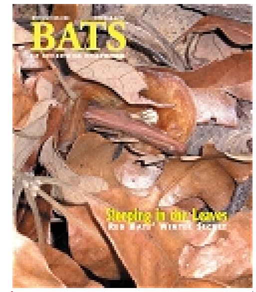
VOLUME 22, NO. 2 Summer 2004



View PDF version [8.12 MB]

Amazing Diversity
Different strokes for different moths?
Jesse R. Barber

The late biologist Kenneth Roeder once jokingly labeled tiger moths the pessimists of the insect world because of the ultrasonic curse they utter upon hearing the ominous beeps of a hunting bat's biosonar. He may have been right about the moths' urge to communicate. Mounting evidence ("Dueling in the Dark," page 10) indicates a clicking tiger moth is sending the bat an ultrasonic warning that it would make a toxic meal. The tiger moth's noxious nature is due to the many poison-laden plants it consumes in an earlier life as a ravenous caterpillar. Tiger-moth research stretching back five decades has focused primarily on a few easily accessible species in temperate climates. But most of the more than 11,000 species of tiger moths are found only in the tropics. To better understand this diversity and its implications, I spent three weeks this past July black-lighting for moths on the western slopes of the Ecuadorian Andes. Each night, I spent several hours plucking moths off the sheets to which they were drawn by my irresistible ultraviolet lights.

I tested the moths for response to varying levels of touch and to a recorded attack sequence of bat echolocation calls. With its wings pinned back with forceps, each moth was placed with its abdomen an inch or so (a few centimeters) from an ultrasound speaker. To record the moth's response, I placed an ultrasonic microphone close to its left tymbal – one of a pair of the moth's chest-mounted, sound-producing structures.

I recorded more than 500 individual tiger moths of about 120 species. About half of them responded to varying levels of touch, and about half of those reacted to the echolocation attack sequence. Some of those species produced echolocation-response sounds that are several times more complex than any previously recorded sounds of tiger moths.

This increased complexity is especially interesting when considering the possibility that tiger-moth clicks might jam the bat's echolocation. Behavioral and neurophysiological research has shown that if a tiger-moth click reaches the bat within about 2 milliseconds before the biosonar echo returns, the bat's brain response and ability to judge distance are altered.

Given the unpredictable interval of arriving echolocation pulses and the small time scales involved, however, the moth cannot produce clicks aimed at jamming a particular echolocation signal. Therefore, the most likely strategy for interfering with the bat's processing of enough echoes to give the moth time to escape would be to produce more and longer sounds. Several of the species I recorded in Ecuador demonstrate this trait and provide a few other tantalizing clues.

These same species respond poorly to stimulation by touch, but reliably respond to bat calls during the terminal buzz of the final attack. James Fullard of the University of Toronto has suggested that producing sounds during this terminal phase maximizes the consequences of any errors that might be produced by jamming sounds. So while recent research finds that echolocation jamming may not be a viable function of tiger-moth sounds among temperate species, such active acoustic camouflage remains a possibility in the tropics.

One of the most astonishing results of my work is the sheer diversity of different tiger-moth calls recorded during this short trip to the tropics. About 25 percent of the tiger-moth species I studied responded to bat cries. If we assume that approximate percentage holds worldwide, than thousands of species of tiger moths are clicking back at attacking bats.

And they are not alone. While harvesting tiger moths for recording, I noticed a faint squeaking sound from a rather large hawk moth I had accidentally disturbed. This particular moth produced sounds primarily below 15 kilohertz, outside of most bats' best hearing range. That, however, led me to investigate hawk moths, and I quickly identified about a dozen species that produce ultrasonic rasping sounds upon tactile or ultrasonic stimulation.

Some tropical hawk-moth larvae are known to be poisonous, so the moths may be advertising their unpalatability or such other characteristics as large size or dangerously spiked hind legs.

A more intriguing possibility is that hawk moths are mimicking tiger moths, essentially stealing the bats' knowledge of the dangers of eating ultrasound-producing prey. Consider the recent discovery by David Yager of the University of Maryland that tiger beetles may be clicking back at bats by rubbing their wings together upon hearing echolocation pulses.

The skies appear to be full of ultrasonic messages produced by many types of insects and aimed at their bat predators. It is tempting to hypothesize that bats' relative lack of prey discrimination on the wing has forced their prey to come up with systems that notify the bats of potentially nasty interactions. Bats clearly are faced with an incredible array of insect warning sounds. The bats' auditory systems are faced with decoding much more than just the echoes of their biosonar.

JESSE R. BARBER is a Ph.D. candidate at Wake Forest University in Winston-Salem, North Carolina. This research was funded by a grant to J.R. Barber from the Richter Foundation and a grant to Barberâ€™s doctoral Â-adviser, William E. Conner, from the National Science Foundation.

All articles in this issue: